Converse Piezoelectricity

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Piezoelectricity results from a coupling between responses to mechanical and electric perturbations and leads to changes in the polarization due to strain or stress or, alternatively, the occurrence of strain as a function of an applied external, electrostatic field (this is the converse piezoelectricity). Theoretical studies of those properties for extended systems require accordingly that their dipole moment or polarization can be calculated. However, whereas the definition of the operator for the dipole moment for any finite system, independent of its size, is trivial, it is only within the last 1 - 2 decades that the expressions for the equivalent operator in the independent-particle approximation for the infinite and periodic system have been presented. In this presentation, we demonstrate that the so called branch dependence of the dipole moment per unit for the infinite and periodic system is related to physical observables in contrast to what often is assumed. This is related to the finding that converse piezoelectric properties depend both on the boundaries/surfaces of the samples of interest even for samples with size well above the thermodynamic limit. Despite this dependence, we shall also demonstrate that these properties can be calculated without explicitly taking the surfaces into account. Both the foundations and results for real systems shall be presented. Finally, the consequences for short-circuited dielectrics shall be discussed.